A preliminary assessment of the potential of shelterbelts to maintain spider diversity within agricultural landscapes

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Abstract

A once-off pilot study was conducted in north-eastern Victoria to assess the spiders associated with two agricultural landscapes (a vineyard and a grazing property). The study found a total of 225 individual spiders from 19 families. No significant differences were found in the number of families of spiders or total spider abundance between the paddocks and adjacent shelterbelts. However, it is suggested that more sampling on several seasonal occasions may reveal differences because preliminary results indicate that certain spider families have preferences for particular habitat factors (such as the availability of vegetation on which to build webs, or the openness of the ground layer). (*The Victorian Naturalist* **127** (5) 2010, 174-177).

Keywords: shelterbelts, spider diversity, natural enemies, habitat preferences

Introduction

Agricultural practices since European settlement have altered the Australian landscape considerably, and subsequently led to a simplification of vegetational environments. The uniform nature of such landscapes has generally resulted in a loss of biodiversity, including spiders. Non-crop habitats, such as shelterbelts, are now being widely used in Australia to combat land degradation, as well as potentially helping to reduce biodiversity loss by increasing the diversity of vegetation within the agricultural landscapes (Tsitsilas *et al.* 2006).

Spiders are an important component of the food chain in that all species are predatory, and this short study was conducted to assess spiders associated with agricultural landscapes. Spider taxonomy is based primarily on mature males, and identification of females and immature spiders to species is often difficult; however, identification to the family level is easier, and each family can be assigned to a particular hunting strategy (Churchill 1998), and the composition of the spider assemblage can be considered on the basis of family composition. Since heavily modified agricultural land may result in the loss of suitable foraging surfaces for hunting spiders or scaffolding for web-builders (Churchill and Ludwig 2004), the structure of the surrounding environment becomes very important for promoting spiders as predators within an agricultural landscape. Studies from New Zealand and Germany have found that heterogeneous environments can support more invertebrates and more spider species than adjacent pastures (Clough *et al.* 2005; McLachlan and Wratten 2003), although the response of each spider will depend upon its size, mobility, behavioural characteristics and life history (Soulé and Gilpin 1991; Martin and Major 2001). A pilot study, conducted over a short time frame, was undertaken to assess whether shelterbelts in Victoria have a higher richness and abundance of spiders than adjacent paddocks, and if spider family assemblages display preferences for particular microhabitats across these boundaries.

Methods

Study sites were selected from two Victorian farming properties — a vineyard in Rutherglen (36° 1' 43.23" S 146° 36' 27.49" E), and a lucerne property in Picola (35° 59' 6.81" S 145° 8' 43.08" E). The sites were selected to allow comparisons of invertebrate fauna in the shelterbelt and the adjoining agricultural landscape. The shelter-belt at Rutherglen is bordered by vines on both the southern and northern side, creating three sub-sites. Picola consisted of two sub-sites, with a lucerne paddock being located on the southern side of the shelterbelt. Replicate sampling units consisted of three transects set up perpendicular to the shelterbelt-paddock border.

Ground-active invertebrates were sampled using pitfall traps, and above ground taxa were collected using water traps. The pitfall traps were 70 mm in diameter and partially filled with ethylene glycol. Yellow water traps measuring 180 x 120 x 65 mm were filled with water and a drop of detergent. There were 13 sampling points per transect at Rutherglen (five in both paddock sub-sites at distances 10, 20, 30, 40 and 50 m from the shelterbelt, and three within the shelterbelt at 10 m spacings). There were six sampling points per transect at Picola (five in the paddock at distances 10, 20, 30, 40 and 50 m from the shelterbelt, and one 5 m into the shelterbelt). In the paddock sub-sites, pitfall traps were placed at the 10, 30, and 50 m sampling points and water traps at 20 and 40 m. In the shelterbelt sub-sites, pitfall traps and water traps were used at each sampling point.

At each location the traps were all primed on the same day and opened for one week. The traps at Rutherglen were run from 8-15 November 2004, and those at Picola from 9-16 November 2004. When collected, the water traps were passed through a 1 mm sieve to drain the trapping fluid, and then placed into a specimen jar containing 70% ethanol. Mature and immature spiders were sorted to family level (Raven *et al.* 2002).

Summary statistics of spider family richness and total spider abundance were recorded for each site, as well as observations on habitat preferences for some of the dominant spider families. Analysis of variance (ANOVA) was used to test for differences in spider abundance and spider family richness between shelterbelts and adjacent agricultural paddocks. Spider abundance data were averaged per trap and log+1 transformed for normality.

Results

A total of 225 spider individuals from 19 families was collected and identified. A further six individuals could not be identified with any confidence and had to be discarded from the analysis. Spider assemblages show some trend with respect to shelterbelt or paddock location, with mean spider abundance and family richness slightly higher within the shelterbelts (Table 1); however, the results were not significantly different (abundance: $F_{(1,13)} = 0.03$, $P = 0.871$; family richness: $F_{(1,20)} = 2.62$, $P = 0.121$) possibly due to the low sampling effort. The only exception to this trend was found within the water traps at Picola for spider family richness.

Habitat location preferences were observed for a selected group of spider families sampled (Table 2). These observations were limited to the dominant families where predominantly mature spiders were collected. Linyphiidae and Dictynidae show a pattern of preference for paddock environments over shelterbelts, while Salticidae were trapped only within the shelterbelt. Lycosidae appear to have a wide habitat range, being consistently collected both within the shelterbelt and in all pitfall traps up to 50 m into the paddocks.

Discussion

This study has shown that, although there are differences in spider family diversity and abundance of spiders between shelterbelts and adjacent paddocks from two farming systems in north-eastern Victoria, the differences are minor. The low sampling effort meant that it was difficult to analyse the data statistically, and it is probable that with an increased sampling effort these differences would become statistically significant. The only exception to this trend was with the water traps from Picola, where more families were collected from the adjacent paddocks than the shelterbelts. This irregularity may be related to the trapping technique since water traps target flying insects and are, therefore, not an ideal technique for trapping spiders. However, the shelterbelts studied were more vegetationally diverse than the adjacent crops and, since habitat heterogeneity increases the availability of habitats for spiders (Churchill and Ludwig 2004), shelterbelts can potentially increase the number of natural enemies to crop pests within a system. Therefore, incorporating shelterbelts into agricultural landscapes may have a positive effect on crop management in terms of increasing potential natural enemies.

This study indicated that certain spider families show preferences for particular habitats. Although spiders are often classified as generalist predators, they do include specialist predators, so the variance in location may depend on the family's primary foraging mode.

The preference for paddocks shown by Linyphiidae is supported by a number of studies (Sunderland and Samu 2000; McLachlan and

Table 1. Mean abundance of spiders and family richness for shelterbelt and paddock sub-sites at Picola and Rutherglen.

		Mean abundance		Family richness	
		Shelterbelt	Paddock	Shelterbelt	Paddock
Picola	Pitfall traps	1.83	1.75	6.33	4.33
	Water traps	1.10	1.06	3.0	6.0
Rutherglen	Pitfall traps	1.63	1.28	5.0	4.67
	Water traps	1.09	0.92	3.33	3.17

Table 2. Dominant spider family abundances with distance from shelterbelt at Picola and Rutherglen.

		Distance from shelterbelt					
		Shelterbelt	10 m (pitfall)	20 m (water)	30 m (pitfall)	40 m (water)	50 m (pitfall)
Picola	Linyphiidae	2	7	1	12	2	1
	Dictynidae	0	1	0	2	1	0
	Salticidae	2	0	0	0	0	0
	Lycosidae	7	4	0	5	1	7
Rutherglen	Linyphiidae	1	0	1	0	3	0
	Dictynidae	1	7	0	0	0	1
	Salticidae	6	0	0	0	0	0
	Lycosidae	11	7	0	3	0	1

Wratten 2003; Clough *et al.* 2005). This may be related to the potential for dispersal offered by ballooning, but linyphiid spiders are sheet web spiders often found between low leaves, so the vines and lucerne may have provided a suitable environment of low leaves to which these spiders could disperse and subsequently build webs necessary for capturing prey. Again, the preference for the paddock environment shown by Dictynidae may be associated with this family's capability of establishing in these types of agricultural systems, because the vegetational structure of the vines and lucerne allows the spiders to colonise the extremities of small branches to form their irregular three-dimensional webs.

Salticidae are diurnal hunters that use their highly developed visual system to stalk prey actively across complex vegetation surfaces. Churchill and Ludwig (2004) found that declines in salticid abundance were significantly related to the reduction in cover of perennial grass patches and tree canopies. Therefore, changes in grass and tree canopy cover across the shelterbelt-paddock boundary may explain why these spiders were collected only from the shelterbelts in this study.

The wide range of Lycosidae is supported by a number of Australian studies (Bishop 1981; Major *et al.* 2006). Lycosids are habitat generalists and strong running hunters, so are unlikely to be affected by shelterbelt-paddock boundaries. Furthermore, these spiders may be dispersing from the complex shelterbelts into the relatively bare ground cover of the adjacent paddocks to find suitable habitat in which to search for prey, as studies have shown that lycosids prefer a low cover of grasses or less complex ground covers for foraging (Churchill 1998; Martin and Major 2001; Churchill and Ludwig 2004).

Since mobility, behaviour and hunting strategies have a clear effect on spider distribution within an environment, the structure of the environment becomes very important when choosing to promote certain spiders as predators. Vegetation that promotes web-building would be preferential for controlling flying pests because these pests are generally captured by orb-web spiders. Yet, complex vegetation surfaces that allow wandering spiders, such as the salticids, to stalk non-flying pests would help increase preying efficiency of these spiders. So, while these characteristics must be taken into account in order to maximise the efficiency of using particular spiders as natural enemies, by maintaining habitat heterogeneity within an agricultural landscape we help to preserve the diversity of spiders, which intrinsically increases general preying efficiency.

This study demonstrated some initial findings that indicate advantages to maintaining shelterbelts within Victorian agricultural systems, but this was a preliminary study and therefore has certain limitations. First, the fauna was sampled only once and, since seasonality has a major influence on invertebrates, it is likely that only a snap-shot of what is happening was revealed. Second, only two collection techniques were used. While pitfall traps may have adequately targeted ground-dwelling spiders, canopy-dwelling spiders were likely to be under represented and may have been better targeted with collection techniques such as beating or sweeping (Neville and Yen 2007). The next step in examining the potential of maintaining spiders within Victorian agricultural systems would be to increase the sampling effort by including more sites, more replications, and taking into account seasonal collections. Furthermore, a more intensive survey that concentrates on the movement of spiders between the shelterbelt and agricultural system could help to indicate whether shelterbelts adjacent to seasonal cropping systems provide a good refuge for spiders in the off season when paddocks are bare.

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